ISOLATION SYSTEM FOR VIBRATORY EQUIPMENT

FIELD OF THE INVENTION

The present invention relates to an isolation system used with vibratory feeders and conveyors. Particularly, the invention relates to a system for damping unwanted motion of an isolation spring member without adversely affecting the efficiency of the system to minimize the transmission of vibratory forces to the equipment's support structure. The invention also particularly relates to an isolation system for mechanically excited vibratory equipment, where feed rate is reduced or stopped by changing the operating frequency of the mechanical exciter.

BACKGROUND OF THE INVENTION

Vibratory feeders and conveyors are installed onto an equipment support structure usually within a building structure. Vibratory feeders and conveyors utilize some form of isolation system to minimize the transmission of unwanted vibratory forces to the equipment support structure, and to the building structure in which it is installed. Without the isolation system, the building and equipment support structures would vibrate from the transmitted forces, creating high noise levels and undesirable working conditions. If a structural member, or structural assembly, associated with the support structure of the vibratory feeder or conveyor has a natural frequency near the operating frequency of the vibratory feeder or conveyor, or near a harmonic of the operating frequency, the amplitude of the vibration could possibly reach detrimental levels.

Typical isolation systems consist of a soft spring element to absorb the vibratory energy, and a structural means to support or suspend the equipment from the spring element. Generally, the spring element is a steel coil, steel or reinforced plastic leaf, block of rubber, or an air filled rubber sphere or cylinder. The spring element design is selected depending on the isolation characteristics of the vibratory feeder or conveyor and the economics of the particular design. For example, a steel coil spring is strong, but can be designed to have a soft spring rate in its vertical axis, and thus might be selected as an economical means to isolate vibratory forces that have large vertical components, and where heavy static loads are involved. On the other hand, a coil spring is relatively large, heavy, and because steel is very lightly damped, is sensitive to vibratory motion over a broad frequency range. Such a broad frequency range can be a problem if the frequencies happen to be close to a frequency of one of the natural vibration modes of the coil spring.

Rubber springs are often chosen because they are lighter, dimensionally smaller for a given spring rate, and more highly damped. However, it is often more difficult to design a rubber spring block to have an equally low spring rate because of design constraints limiting deflection, particularly in compression. Therefore, the design compromises in using a rubber spring block may be that the vertical isolation is less efficient, for example. Also, the rubber spring isolator tends to be more costly for a given spring rate due to a higher cost manufacturing and quality control process.

The problems associated with isolation systems are often compounded by the way in which users select equipment, install the equipment, and then operate their production processes using the equipment. Many processes require frequent stopping and starting of the equipment. This can create a problem for fixed frequency, mechanically excited vibratory equipment, as the frequent switching on and off could cause the electric motor to overheat, and perhaps to prematurely fail. In order to prevent such problems from occurring, rather than turning the machine's electrical supply off to stop the conveying, many users reduce the operating speed of the equipment to a level where the material being fed is no longer conveyed.

This reduction in speed might be accomplished with the use of a variable frequency motor controller, the output frequency of which can be switched from the normal line frequency to a lower frequency on demand. This is usually accomplished by an output from a sensor that is monitoring various downstream process parameters such as feed rate, flow depth, etc. In the case of two mass feeders and conveyors, the controller might be a voltage control device, switching voltage output to the motor, between a supply line voltage level, and a lower voltage level, to effectively change the motor speed and thus control the feed rate.

Unfortunately, while a two speed operating level reduces process equipment problems, reducing to the lower frequency can create a problem for the isolation system. The reduced frequency may sometime be close in frequency to the natural frequency of the isolation springs, causing large vibration amplitudes of the undamped spring, noise, wear or failure of the isolation system components. It is also possible that such low frequency vibratory forces transmitted through the support structures can cause the isolator springs on adjacent feeders to also resonate through sympathetic excitation, even if their associated vibration equipment is turned off. Very little energy is required to produce high amplitude motion of a typical undamped steel isolator spring, if the transmitted frequencies are close to any of the natural frequencies of the bending mode of the spring.

When vibratory equipment is installed, especially cable suspended equipment, it is sometimes difficult to get the trough member to be perfectly level with respect to a horizontal reference plane. While floor mounted isolation support members can be varied in elevation using leveling plates (shimmied-up) to become level, it is more difficult to level suspended equipment without adding tumbuckles or the like in the suspension cable. Turnbuckles, and other cable length adjusting mechanisms, are effective at leveling, but add mass to the cable system, lowering its natural frequency to be within the range of the equipment's operating frequencies, which can make the cable's whip or become noisy.

SUMMARY OF THE INVENTION

The present invention provides an improved isolation suspension system for a vibrating machine such as a vibrating feeder or conveyor. The system includes one or more suspension assemblies supporting portions of the machinery. The suspension assembly includes a housing holding an isolation spring or support spring, and a damping spring or damper element. The isolation spring preferably is a coil spring and the damping spring is an elastomer ring. The damper element acts in conjunction with the isolation spring. The isolation spring supports the vertical superimposed dynamic forces of the feeder or conveyor and deflects in compression a short distance. The damper element prevents unwanted motion of the isolation spring due to the vibratory equipment operating frequency being close to any of the natural frequencies of the isolation spring's bending modes, by applying an opposing load to any such motion.

The preferred embodiment suspension assembly can be provided as a hanger component or a support component.